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From: Director of Naval Intelligence
To: Distribution List

Subj: Tests of East German Subminiature Tubes (U)

Ref: (a) ONI 10-S-56, of June 6, 1956, entitled "Evaluation of Certain Soviet Marine Electronic Equipment"
(b) Spec. MIL-E-1/20C of 18 June 1957 for Electron Tube Type 1AD4.

Encl: (1) Report on Subminiature tubes

1. This report summarizes results of tests of East German vacuum tubes conducted by the New York Naval Shipyard. These tubes were among the few subminiature types ever recovered from the Soviet Bloc capable of use at fairly high radio frequencies. The tube samples were made in the VEB RFT Werk fuer Fernmeldewesen (OSW), East Berlin, in May 1962. This plant has been considered the most capable tube plant in East Germany.

2. As indicated in the report, the tubes were very similar to the U.S. Raytheon (Tung-Sol) type 1AD4, a sharp cutoff r-f pentode, used in r-f and audio applications in small portable equipments. The British Mullard DF-62 and the European DF-652 subminiature tubes are considered equivalent to the Raytheon (Tung-Sol) model; there is no proof which tubes were used as prototypes. The two tubes (two samples each) are indicated as MCN-21095 and MCN-21096 respectively.

3. The test results indicated the tubes were reasonably satisfactory equivalents to the comparable U.S. tubes, as in many prior tests of Soviet-Bloc tubes, such as those outlined in reference (a). It is an interesting tribute to the technology of East Germany as of 1962 vintage, that this is the case, although the Western prototypes date in design from the mid-fifties. It is verified that the East Germans can produce subminiature tubes of reasonable modernity, comparable to U.S. and West European standards, despite continued reports of production difficulties.

GEORGE GRKOVIC
By direction

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TECHNICAL REPORT

REPORT OF SUBMINIATURE TUBES

MCN 21095 & MCN 21096

Naval Scientific & Technical Intelligence Center

OFFICE OF NAVAL INTELLIGENCE

GROUP - 3
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Report on Subminiature Tubes

1. A study and evaluation were performed on two groups each comprising two subminiature tubes procured from East Germany. The objective of the assignment was to determine the function, operational characteristics, durability and reliability of the sample tubes, as part of the Foreign Material Exploitation Program. The two groups of tubes are designated MCN-21095 and MCN-21096. In this report the four sample tubes are also identifiable by numbers 11 and 12 for the tubes of group MCN-21095, and numbers 21 and 22, for those of group MCN-21096, respectively.

2. Consideration was given to methods high-lighting a previous exploitation study of subminiature tubes similar to the subject tubes. Due to the limited time available, this report is restricted to the evaluation of the tube functions and electrical characteristics, excluding those necessitating destructive tests. The report further presents details of the physical structure and chemical composition of the tube components and also offers comments on the workmanship.

3. A visual inspection revealed that subject samples were 6-lead subminiature tubes with flat press bases and T2x3 envelopes. On all sample tubes one lead, later identified as the original No. 3, was cut flush with the tube base, and all remaining leads cut to 1/4 inch, approximately. There was no recognizable marking of any kind on the envelopes, nor was there any reference indicating pin Number 1. The inspection confirmed that the tubes were filamentary pentodes, with spring loaded filaments, using beam forming plates for suppressor grids.

4. In the absence of any information concerning the tube types or the appropriate test voltages, and in view of the very limited total number of samples available (4), particular precautions were taken to prevent electrical or physical damage to the tubes. For the purpose of establishing a basis for determining the test voltage conditions, and on the assumption that the foreign tubes may be copies of, or similar to, one or more USA types, an extended study was made of USA subminiature types of similar size, envelope and structure. The following tube types were tentatively selected as possible equivalent or near-equivalent types of the foreign tubes: 1AD4, 1AH4, 5678, 5875, 5972, 6051, 2E31, 2E32, 2E35, 2E36. Based on the analysis of exhaustive preliminary parameter measurements, all but one, USA type 1AD4, were eliminated. However, USA type 1AD4 revealed marked similarities in electrical characteristics, the size of envelope, electrode structure and even pin arrangement, since the tubes under investigation can be considered 5-lead tubes, due to the cut-off pin. This change to a 5-lead tube appears to confirm the intended similarity to the 5-lead, oval base USA type

1AD4, manufactured by Tung-Sol, Raytheon. However, a difference between the two tube types is that tube type 1AD4, unlike the foreign tubes, possesses a metallic paint external shield connected to lead No. 3 (suppressor).

5. The investigation was directed toward determining the electrical characteristics of the tubes, the physical dimensions, structural details and chemical composition of the electrodes. For the purpose of establishing the degree of equivalance, two samples of USA type 1AD4, manufactured by Tung-Sol, were included. The results of the measurements and the test conditions are shown in Tables 1 and 2, and in Figures 1, 2 and 3.

6. It should be realized that irrefutable statistical results should be based on a much larger sampling than the four tubes available for this evaluation.

7. Analysis of the electrical characteristics presented in Table 1 and Figures 1, 2 and 3, reveals marked parametric similarities, not only among the tubes of both subject groups MCN-21095 and MCN-21096, but also between these two groups and the USA type 1AD4. The differences between the values of the parameters among the individual samples fall within the normal spread of the characteristics. This is evidenced by the specification limits as shown in Table 1. The only exceptions seem to be several values of interelectrode capacitance, which do not meet the applicable specification limits of the 1AD4, shown in parentheses. It should be noted that the external shield of the 1AD4 was removed so that direct comparison of the interelectrode capacitance values could be made with the foreign tubes, which do not have shields. In general, the subject tubes display slightly higher plate resistance, a higher grid cut-off voltage, and, in the Pulse Test, Figure 3, reveal better pulse emission properties at below nominal filament voltage. The Pulse Test also reveals that all samples under investigation were of above average working condition.

8. The similarities previously mentioned between the electrical characteristics of the East German tubes and the USA type 1AD4 extend to the physical characteristics, structural details and chemical composition of the tube parts, as shown in Table 2. The major areas of similarity are:

a. The dimensions of the filaments, and method of spring loading.
b. The diameter and number of turns of the control and screen grid wires.
c. The size and shape of the beam forming suppressor grid structure surrounding the plate.
d. The area of the plate surfaces (indicating equivalence of plate dissipation).
e. The lead-to-electrode lay-out (disregarding the cut-off lead No. 1 of the German tubes).
f. The mount structures.
g. The coating of the mica spacers.
h. The chemical composition of the tube parts, shown in Table 2, obtained by qualitative spectroscopic chemical analysis.

9. The physical and structural dissimilarities observed are of minor importance and include the following:

a. Structural differences in the getter assembly.
b. Variations in tube bases, i.e., flat press for the foreign tubes vs. oval base for the USA type, as manufactured by Tung-Sol.
c. An extra mica is placed in the 1AD4 underneath the getter (to prevent leakage problems produced by the deposit of gettering material between electrodes).
d. Type 1AD4 envelope is coated with a shield of metallic paint while East German tubes do not have a shield.
e. The external leads of the USA tube are tinned, those of the German tubes are copper-plated.
f. The cathode coating of the foreign tube is considerably thicker than that of the 1AD4.
g. The German tubes use the lead originally designated No. 1, (cut flush with the tube base) as additional support for the mount. The USA counterpart uses two internal "L" shaped wires for the same purpose.
h. In the East German tubes the shoulders of grid Number 3 and the plates (anode) are seated against the top and bottom micas, respectively, thus providing greater rigidity for the mount structure. In the USA type, similar construction is utilized with the exception of the lower plate shoulders which do not reach to the bottom mica.

10. The following conclusions are drawn from this investigation:

a. The East German subminiature tubes designated MCN-21095 and MCN-21096 are sharp cut-off r-f voltage amplifiers.
b. Due to the close similarity of physical features, chemical composition, electrical characteristics and plate dissipation with type 1AD4, the East German tubes are considered as direct equivalents of USA type 1AD4, with identical range of application. Design, construction and workmanship are considered of good quality.
c. It is believed that the similarity of the subject tubes with the USA type 1AD4 is not accidental but probably intended, since type 1AD4 is listed in MIL-STD-200D, dated 29 May 1958, and, thus, by definition represents the "best type available for a given function". This type is also registered in the NATO Priority List for Electronic Tubes.

11. No time was available to determine durability and reliability. However, in view of the marked similarities observed between the subject foreign and USA tubes in material, construction and workmanship, performance of these two tube types is expected to be similar. The only exception is a possible longer life of the foreign type, due to a heavier cathode coating. Also, it should be noted that the sample size was reduced to three tubes, since sample No. 12 of group MCN-21095, after the electrical measurements, was subjected to rigid physical and chemical analysis.

TABLE 1

ELECTRICAL CHARACTERISTICS OF EAST GERMAN TUBES MCN-21095, MCN-21096 AND USA TYPE 1AD4 (TUNG-SOL)

BASING:

Lead No.	1	2	3	4	5	6
MCN-21095 & 21096	cut-off P		G2	F	G1	F
USA 1AD4	P	G2	-F Sh	G1	+F	

TEST CONDITIONS:

	E_f Vdc	E_b Vdc	E_{c2} Vdc	E_{c1} Vdc	R_g Megs	e_{pp} e_{sc} e_{c1} V
A	1.25	45	45	0	2	-
B	1.25	55	55	-1.0	-	-
C	1.00	45	45	0	2	-
D	1.25	45	45	Note 2	-	-
E	1.25	-	-	-	-	35
F	1.00	-	-	-	-	35

TUBE CHARACTERISTICS

Characteristics	Unit	Test Condit.	Notes	MCN-21095 Tube Number 11	12	MCN-21096 Tube Number 21	22	USA 1AD4 1	2	LIMITS Min.	Max.
I_f	mA	A		99	98	98	97	102	103	88	112
Ic1	uAdc	B		0	0	0	0	0	0	-	-0.5

TUBE CHARACTERISTICS

Characteristics	Unit	Test Condit.	Notes	MCN-21095	MCN-21096			USA 1AD4		LIMITS Min.	Max.
				Tube Number							
Ib	mAdc	A		3.60	2.90	2.85	3.05	2.90	3.20	1.9	4.1
Ic2	mAdc	A		1.16	0.88	0.90	0.94	1.03	1.09	0.5	1.3
Sm1	umhos	C		1200	1550	1590	1830	1590	1480	1200	2500
Sm2	umhos	A		2070	2100	2160	2260	1920	2040	1500	2500
Sm3	umhos	C	1, 7	-	1540	1590	1810	1570	1380	1200	2500
r_p	Meg	A		0.437	0.480	0.610	0.450	0.283	0.420	0.2	-
E_c cut-off	V	D	2	4.30	4.18	4.61	4.15	3.60	3.57	-	-
Cgp	uuf	-	3, 4, 5	0.112	0.113	0.082	0.083	0.078	-	(-	0.01)
Cin	uuf	-	3, 4, 5	4.040	3.950	3.940	3.975	4.015	-	(3.0	5.0)
Cout	uuf	-	3, 4, 5	2.942	2.952	2.910	2.960	2.765	-	(3.0	5.0)
Figure of Merit (calculated)			6	513	532	549	570	478	-		
Pulse Emission	mA	E,F	8	see Figure 3				see Figure 3		-	-

Notes:
(1) With all voltages applied, readings taken after 15 minutes
(2) Ec1 set for Ib = 10 uAdc
(3) All measurements without shield; shield of 1AD4 removed
(4) Readings approximate, due to leads cut to around ½"
(5) Limits are for 1AD4 with shield; limits for unshielded tubes not available
(6) Figure of Merit = $\frac{\text{Sm (umhos)}}{\text{Cin (uuf)}}$
(7) Sm3 readings of tube No. 11 very unstable, varying from 880-1160 umhos
(8) Tube is diode - connected

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TABLE 2

PHYSICAL DIMENSIONS AND QUALITATIVE SPECTROSCOPIC CHEMICAL ANALYSIS

FOREIGN TUBE NO. 12 OF GROUP MCN-21095 vs. USA TYPE 1AD4 (TUNG-SOL)

PARTS	TUBE	
	MCN-21095, No. 12	USA 1AD4
Envelope		
Material	Glass	Glass
Outline	T2x3	T2x3
Base	Pinch press	Oval
Shield(Metallic Coating)	No	Yes
Leads		
Material	Copper clad steel, untinned	Tinned steel
Dumet	No	Yes
Filament		
Material	Tungsten	Tungsten
Wire diameter	1 mil	1 mil
Coating diameter	3 mils	2 mils
Total length	0.731 inch	0.731 inch
Coating Material	Barium + (probably)Strontium	Barium + Strontium + Calcium
Control Grid No. 1		
Laterals		
Material	Molybdenum + some Tungsten	Perma Nickel
Diameter	1 mil	1 mil
Number of Turns	80	75
Pitch	130 TPI	120 TPI
Side rods		
Material	Nickel-Manganese alloy	Grade D Nickel
Diameter	16 mils	15 mils
Screen Grid No.2		
Laterals		
Material	Nickel-Molybdenum, traces of iron	Perma Nickel
Diameter	2 mils	2 mils
Number of Turns	56	57
Pitch	94 TPI	94 TPI
Side rods		
Material	Nickel-Manganese alloy	Grade D Nickel
Diameter	20 mils	20 mils

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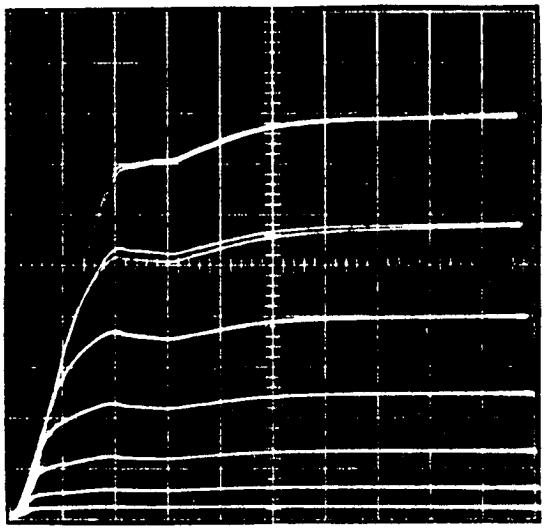
Suppressor Grid No. 3 (Beam forming grid)		
Material	Nickel plated steel	Nickel or carbonized Nickel
Thickness	6 mils	6 mils
Aperture	76x505 mils	76x505 mils
Plate		
Material	Nickel clad steel	Grade A Nickel
Thickness	6 mils	6 mils
Getter		
Material	Barium-Magnesium-Aluminum	50% Barium + 50% Aluminum
Tensioning Spring for Filament		
Material	Tungsten alloy	Tungsten
Diameter (wire)	4 mils	4 mils
Number of turns	6	5
Mica		
Coating	Magnesium Oxide	Magnesium Oxide
Thickness of Mica	-	-
Total Thickness (mica+coating)	10 mils	10 mils

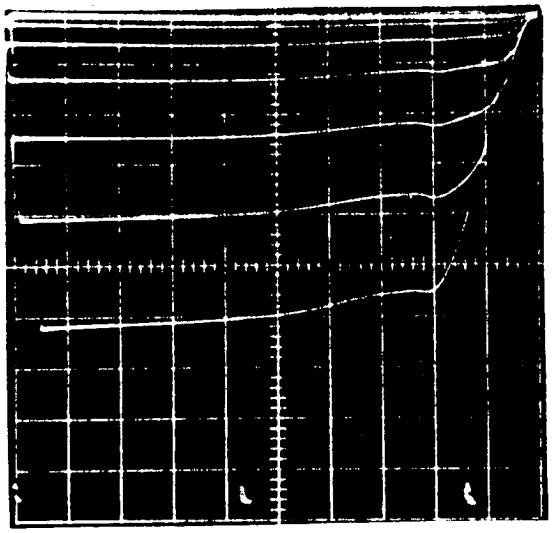
Test Conditions

Ef= 1.25V. Ec2= 45V. Bias Steps= 0.5V.
Ep Sweep= 0-50V. Ib= 0.5mA/div.

Tube No. 11

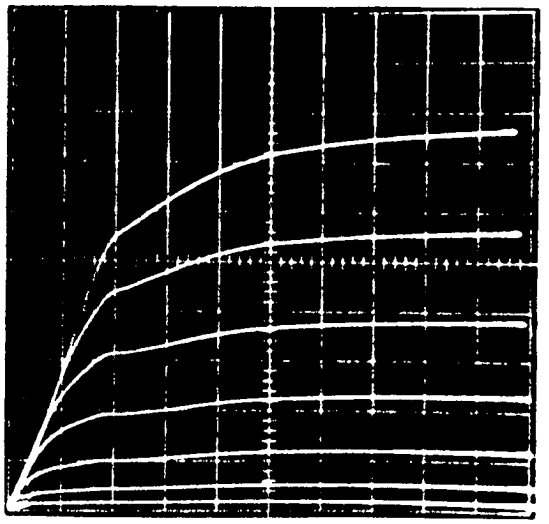


MCN-21095



Tube No. 12

USA Type 1AD4



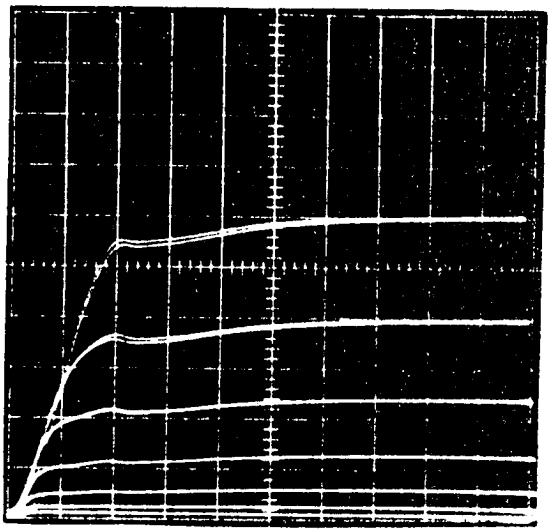
Tube No. 1

Figure 1 - Plate Characteristics
Plate Current vs. Plate Voltage

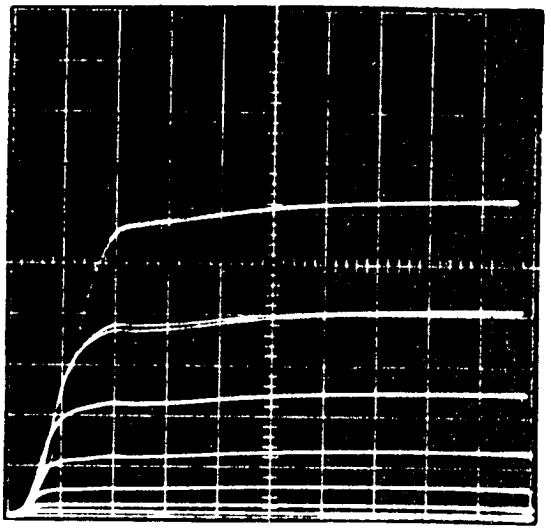
Test Conditions

Ef= 1.25V. Ec2= 45V. Bias Steps= 0.5V.
Ep Sweep= 0-50V. Ib= 0.5mA/div.

Tube No. 21

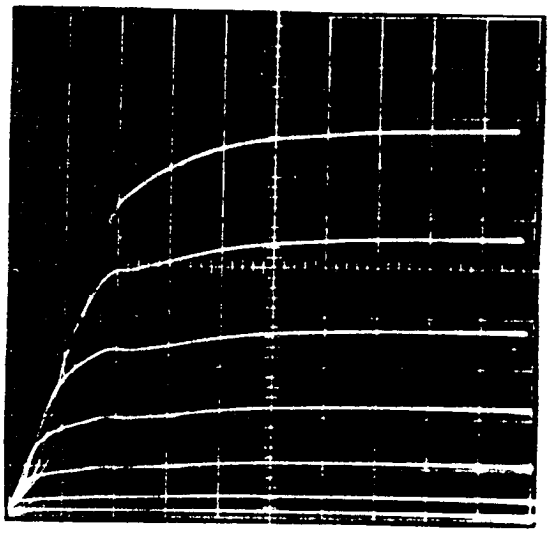


MCN-21096



Tube No. 22

USA Type 1AD4



Tube No. 2

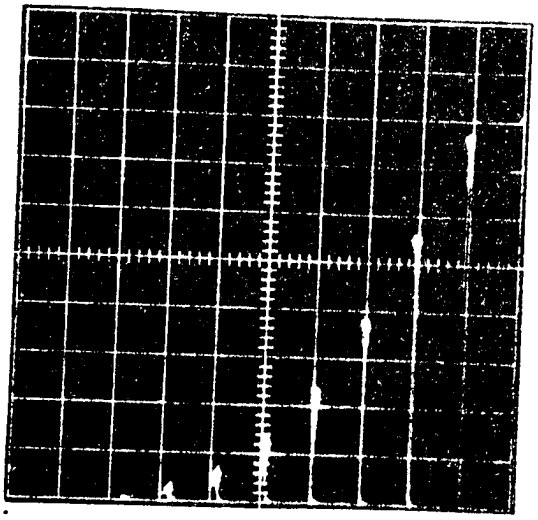
Figure 1 - Plate Characteristics
Plate Current vs. Plate Voltage

Test Conditions

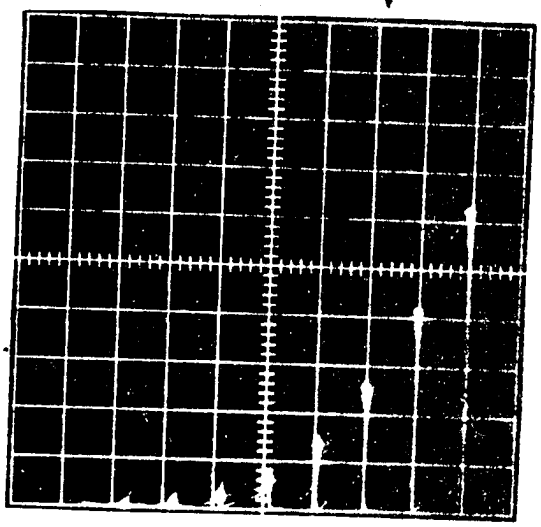
Ef= 1.25V.
Eb=Ec2=45V.

Ib= 0.5mA/div.
Bias Steps= 0.5V.

Tube No. 11

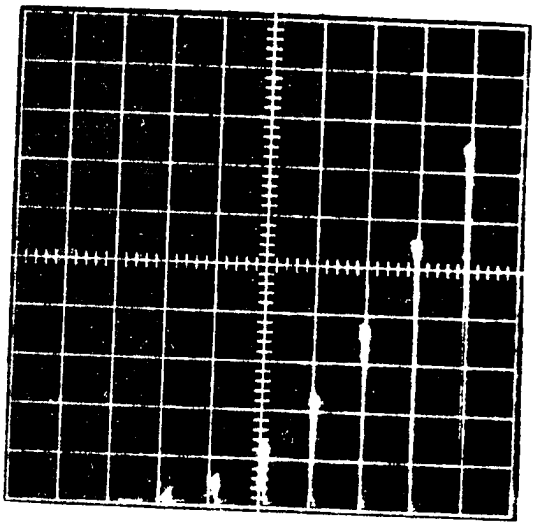


MCN-21095



Tube No. 12

USA Type 1AD4



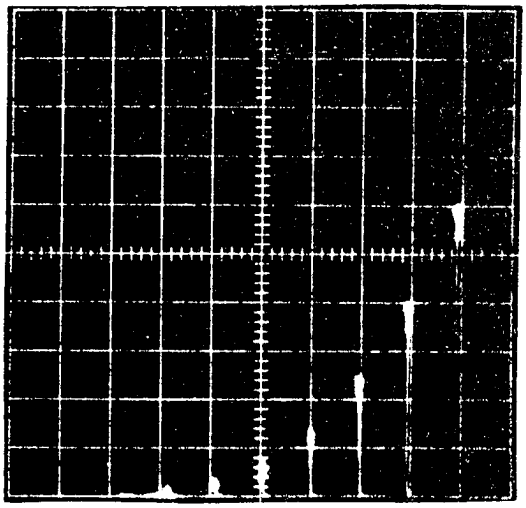
Tube No. 1

Figure 2 - Transfer Characteristics
Plate Current vs. Grid Voltage

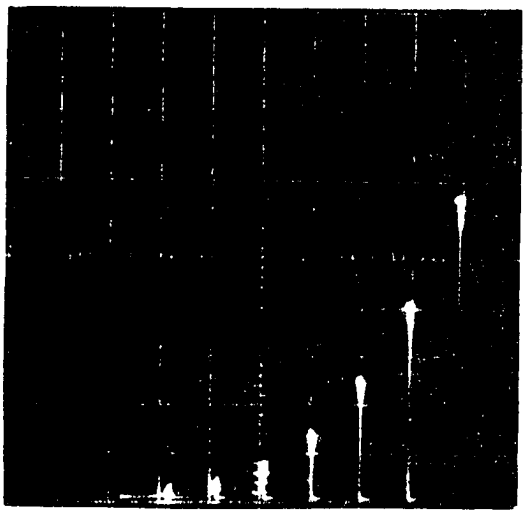
Test Conditions

Ef= 1.25V.
Eb=Ec2= 45V.
Ib= 0.5mA/div.
Bias Steps= 0.5V.

Tube No. 21

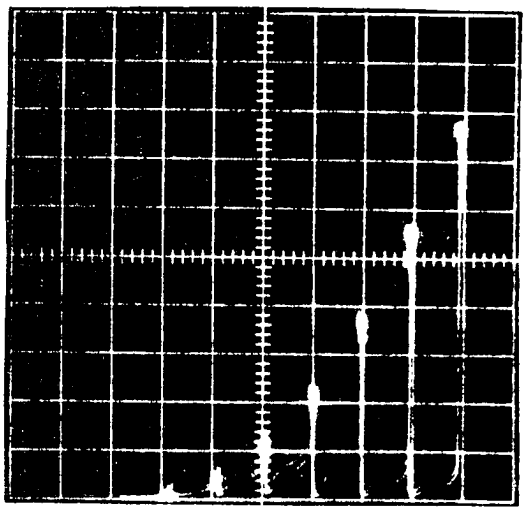


MCN-21096



Tube No. 22

USA Type 1AD4

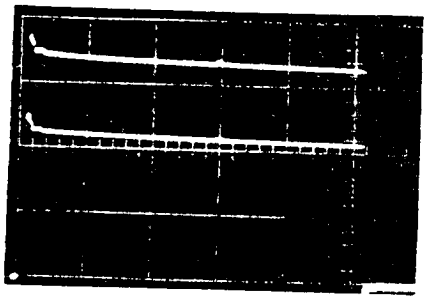


Tube No. 2

Figure 2 - Transfer Characteristics
Plate Current vs. Grid Voltage

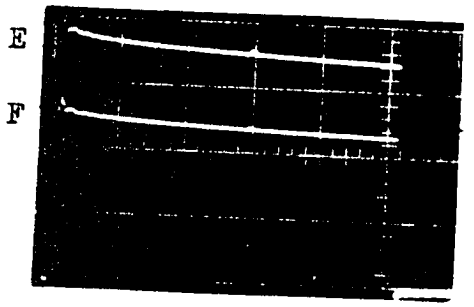
Test Conditions:

E.....Ef= 1.25V. Pulse Width= 25 usec.
F.....Ef= 1.00V. PRR= 200
epp=esc=eccl= 35v.

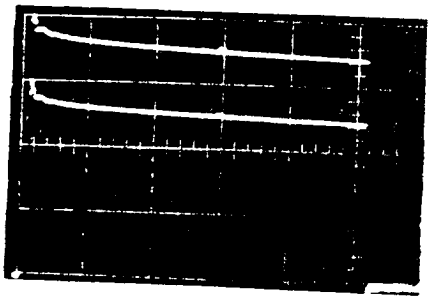


Tube No. 11

MCN-21095

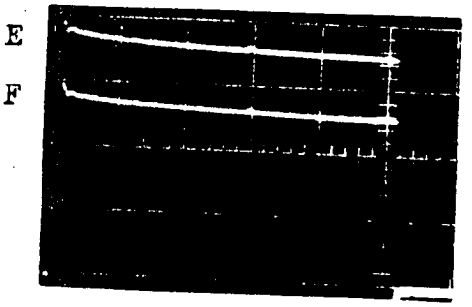


Tube No. 12

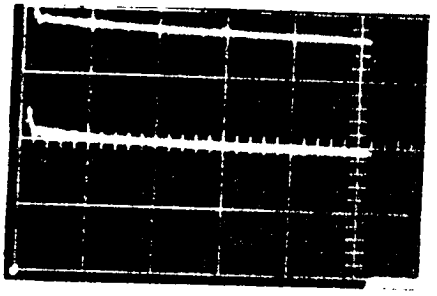


Tube No. 21

MCN-21096

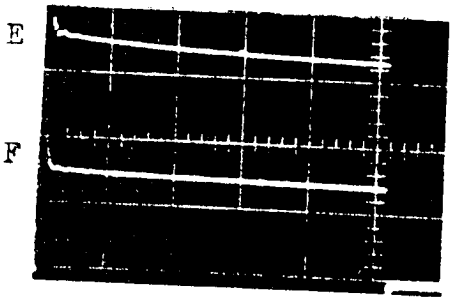


Tube No. 22



Tube No. 1

USA Type 1AD4



Tube No. 2

I= 50mA/div.

Figure 3 - Pulse Emission
Pulse Amplitude vs. Filament Voltage

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